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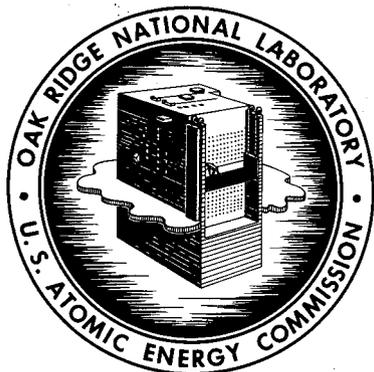
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PANEL DISCUSSION ON CIVIL DEFENSE
AMERICAN NUCLEAR SOCIETY ANNUAL MEETING
WEDNESDAY EVENING, JUNE 23, 1965
GATLINBURG, TENNESSEE



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DIRECTOR'S DIVISION

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Participants

A. M. Weinberg
Director, Oak Ridge National Laboratory
(Moderator)

D. F. Cavers
Fessenden Professor of Law
Harvard Law School

T. T. Stonier
Associate Professor of Biology
Manhattan College

T. B. Taylor
Deputy Director for Scientific Affairs
Defense Atomic Support Agency

E. P. Wigner
Professor of Physics
Princeton University
(On leave as Director of Civil Defense Study Project,
Oak Ridge National Laboratory)

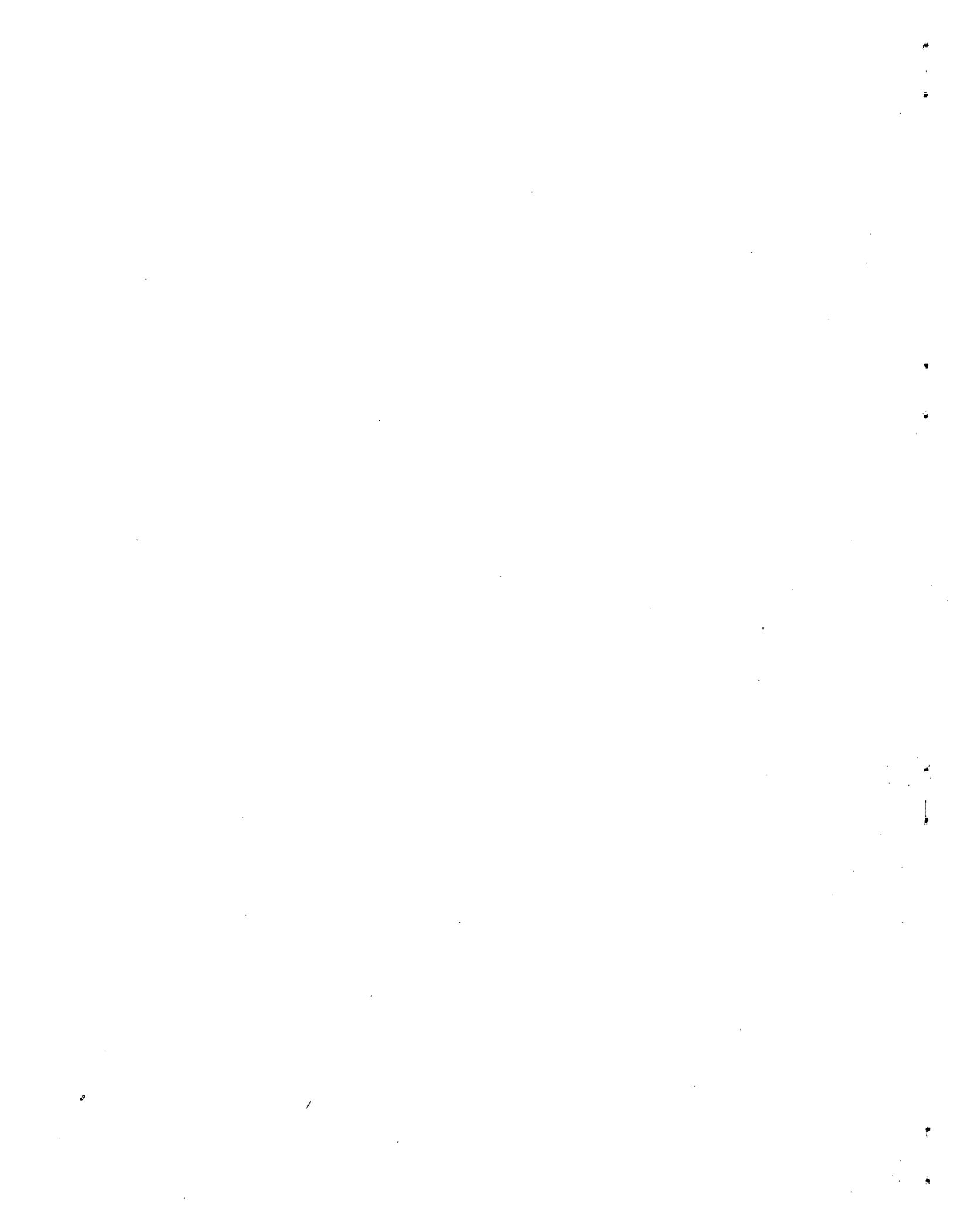
SEPTEMBER 1965

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Professor D. F. Cavers, Fessenden Professor of Law, Harvard
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Professor T. T. Stonier, Associate Professor of Biology,
Manhattan College

Dr. T. B. Taylor, Deputy Director for Scientific Affairs,
Defense Atomic Support Agency

Professor E. P. Wigner, Professor of Physics, Princeton
University (on leave as Director of Civil Defense Study
Project, Oak Ridge National Laboratory)

Opening Comments by A. M. Weinberg

On behalf of the American Nuclear Society it is a pleasure to welcome all of you this evening to the panel discussion on the subject of civil defense.

Ours is a troubled age, and we who have devoted our lives to the exploitation of nuclear energy have contributed mightily to the trouble, but we have also contributed to the means for resolving the trouble. Whether we as nuclear scientists feel that our constructive contributions in the development of cheap energy sources or of nuclear technology have, as Senator Gore said last night, helped stabilize our troubled world, or whether we feel the guilt that he expressed in his talk, no doubt everyone of us feels involved--involved in ways other than merely as scientists and engineers. The symposium this evening is to cover a particularly difficult and troublesome aspect of this involvement--the question of civil defense. There are few great issues that face the nation today more complex, more controversial or more elusive than the question of civil defense. The question is partly technical (Is civil defense technically feasible?),

NOTE: All brackets in the text indicate material which was deleted from the oral presentation because of a time shortage. In other places there have been deletions by the speaker of extraneous material for the purpose of conciseness.

partly political (Is civil defense politically feasible?), and partly emotional (Is civil defense desirable?). The American Nuclear Society, representing the technical community that by and large is closest to many of the engineering problems of civil defense, decided that a public symposium, in which the major problems underlying civil defense could be explored, would be of service to our members and to the American public.

The idea for this symposium originated with Everitt P. Blizard,¹ who was honored last night for his unstinting service to the nuclear energy community as editor of Nuclear Science and Engineering. Mr. Blizard has, for the past year, taken a leading role in the newly formed Civil Defense Project at the Oak Ridge National Laboratory. It is a matter of deep regret for all of us that because of his illness he is unable to be here this evening.

Since the question of civil defense is so ramified and so controversial, we decided to conduct our symposium in such a way as to present all sides of the question. Thus, two of our speakers--Professor Cavers of Harvard and Professor Stonier of Manhattan College--will present the case against civil defense, and Professor Wigner of Princeton (now on leave at the Oak Ridge National Laboratory) and Dr. Taylor of the Defense Atomic Support Agency will present the case for civil defense. Each speaker will be allowed 15 minutes in which to make his opening statements. The opening statements will be followed by a discussion between the panelists and this will be followed by a question and answer period from the audience, the length of which will depend upon the temperature both of the discussion and of the ambient air in this hall.

Our first speaker who will speak on behalf of civil defense is Dr. Ted Taylor, formerly of the General Atomic Division of General Dynamics and now Deputy Director for Scientific Affairs of the Defense Atomic Support Agency. Dr. Taylor, born in Mexico though a United States citizen, received his doctorate in theoretical physics from Cornell. He was an

¹The symposium was proposed by Professor William Kimel of Kansas State University and organized by Everitt P. Blizard at the request of the ANS Education Committee which Professor Kimel chaired. James C. Bresee took over arrangements when Mr. Blizard fell ill in April.

ensign in the Navy during the war and after three years at the Berkeley Radiation Laboratory spent some seven years at Los Alamos designing nuclear weapons. For this work he received this year the E. O. Lawrence Memorial Award of the Atomic Energy Commission. He joined General Atomic in 1956 and, among other tasks, was largely responsible for the detailed conception of the "Orion" nuclear explosion rocket propulsion system, the system that George Gamov called the "kick in the pants" rocket. Dr. Taylor brings to the discussion a broad knowledge of nuclear weaponry as well as knowledge of existing defense measures against nuclear weapons. I therefore take great pleasure in calling on Dr. Taylor who will present a statement on behalf of civil defense. Dr. Taylor.

Dr. Taylor: Thank you, Dr. Weinberg. I should start with the usual preamble that what I have to say about civil defense is my own opinion and doesn't necessarily reflect any official position of the Department of Defense, or any other government agencies for that matter.

A 50-megaton clean bomb exploded a few miles above New York City would kill about 10 million people and destroy most of the buildings within an area greater than about 500 square miles. A 50-megaton, 1/2-fission, 1/2-fusion bomb exploded on the surface of a rural area in New York would kill approximately 30 thousand people by blast and fire alone; and, depending upon the winds, the impact point, and whether the fallout pattern included a large city like New York City, several hundred thousand to over 10 million people would be killed by fallout from an explosion of this sort.

The United States and the Soviet Union are now able to build bombs of this kind and to deliver them by a variety of means, ranging all the way from intercontinental ballistic missiles to some type of covert emplacement. There is little doubt that the United Kingdom could also do so if they wish. France and China have built and tested several fission bombs already. I have little doubt that they too could build a 50-megaton bomb and achieve some means of delivering it within a few years. I also believe that any or all of at least a dozen additional countries could build at least a few fission bombs and perhaps a few large thermonuclear bombs within the next decade or two unless some kind of a means for international control of atomic energy is developed.

About 25 United States metropolitan areas which have over a million inhabitants account for about 35% of the United States population. About 10 metropolitan areas in the USSR have over a million people, and these account for about 10% of the Soviet population. Communist China has about 6% of its population in roughly 15 metropolitan areas with populations over one million.

These are some of the grisly facts of the age that we live in. Different people react to them in different ways. Some refuse to think any further about them. Others think about them a great deal and become convinced that there is no real hope for the future and proceed, as I would call it, simply to "wail at the wall." Still others advocate one or more of various measures. I believe that the most significant measures that have been advocated as possible counters to the threat of some kind of nuclear disaster have been the following:

First of all, the establishment of a world court of law and some kind of international police force, leading eventually to some form of world government;

Second, arms control and disarmament among the sovereign nations;

Third, the maintenance of a state of stable mutual deterrence state between the major powers;

Fourth, the buildup of active defenses against all likely strategic delivery systems;

Fifth, a national fallout shelter program;

Sixth, a large civil defense program based on blast, fire, and fallout shelters and detailed plans for postattack recovery; and

Seventh, gradual decentralization away from large urban areas of population.

I do not believe that any of these measures taken alone is an adequate response to the exceedingly dangerous situation that humanity has gotten itself into. Among those who worry about these things there is a tendency to choose one grand solution and then pit this against all others in what often reaches a very high emotional pitch. I advocate essentially all of the measures I have just listed, but I believe that they vary considerably in the extent to which they can solve our problems and in the time within which they can be brought about. I do believe, however, that there is productive work that can be started on each one of them right away. Steps leading to some of the measures have been under way for sometime.

I believe that some form of world government will be required to maintain permanent stability against serious damage to the human race from the use of weapons of mass destruction. But I also strongly believe that we must do many other things while we are working toward this ideal goal.

I think it is imperative that we establish, as soon as we can, some means for international control of the production and distribution of fissile material. Other arms control and surveillance measures which may be acceptable to the major powers somewhat sooner will also help to reduce the probability of major nuclear disasters. But I cannot conceive of any inspection system and control system which would prevent the assembly of at least a few nuclear explosive systems or bacteriological weapons which could produce exceedingly large numbers of casualties in the world of today. We must simply face up to the reality that, given the relevant knowledge, it takes a very small effort on a national scale to produce large nuclear explosives, once given a few kilograms of fissionable material; fissionable material itself is becoming at least somewhat easier to produce in a greater variety of different ways as time goes by. This is why I believe that arms control and inspection alone are not sufficient for world security. They do, however, offer the long-range possibility of limiting the damage which can be caused by any group of people to some level which can be tolerated by humanity as a whole.

I believe that our deterrent forces have played a major role in preventing nuclear disasters. But we should remember that these forces are effective only if we can identify an aggressor; and therefore they can't be relied upon to prevent either threats of massive civil damage, or damage itself, by groups whose cause does not require them to reveal their identity. A revolutionary group, for example, could use nuclear explosives as a threat by which to enforce immediate, public disarmament by some major power or powers. Or, at least, this could be used as the excuse for making threats of various kinds. Furthermore, I believe that the threat of massive retaliation against each other by all major powers may lead eventually, perhaps through error, to full-scale war.

I believe the effective defense of many cities against a determined effort by a powerful country to destroy them with ballistic missiles is

exceedingly difficult and may be hopeless. But active defenses against both long-range bombers and ballistic missiles can be very effective against attacks by small numbers of carriers, corresponding to the sort of threat that might exist if arms control measures prevented the buildup of exceedingly large forces. Such defenses could also be effective against attack by countries which have not yet been able to build up a large and sophisticated offensive force. There are also some indications that ballistic missile defense to protect major cities would be much more effective if the interceptions can be done at relatively low altitudes. Therefore we will see a coupling later on between the ballistic missile defense problem and the question of shelters.

Now when it comes to shelters, I find it very difficult to think of fallout, blast resistant, and fire resistant shelters in different categories, simply because any type of underground shelter is to some extent effective protection against all three effects. It can hardly be disputed, I believe, that buried shelters which could withstand, say, 100 psi and total destruction of the surroundings by fire would drastically reduce immediate casualties from a nuclear attack. Such a shelter system and effective postattack plans could reduce the number of people killed by a 50-megaton low-altitude airburst over New York City to less than one million people. The number of people killed by blast and fire in similar shelters following a 50-megaton detonation on the surface of the New York State countryside would be of the order of 1000 people. If one-half the yield were fission, then fallout could still be an important problem after two weeks for a few hundred thousand people or less. But postattack decontamination plans and equipment could reduce the fallout hazard much further.

I believe that a United States national fallout shelter program, at least, is demanded by reason. Large populated areas which cannot be protected against fallout are simply too enticing targets for irresponsible groups of individuals, not even necessarily representing a nation. A 100-kiloton surface burst of a fission bomb, under certain occasionally achieved weather conditions, could deposit enough fallout to kill most of the people in any of our largest cities. A 50-megaton surface burst would kill of the order of a million people even in a rural environment in the

United States. Fallout shelters would reduce these numbers by very large factors. I find it difficult to conceive that arms control and inspection could with high probability guarantee that large numbers of people could not be killed or threatened by irresponsible acts leading to the explosion of a very small number of very large yield "dirty" devices.

But I should also point out that fallout shelters alone would not prevent the killing of approximately one-third of the United States population by the blast and fire effects from approximately twenty-five 50-megaton bombs. It is simply a fact that modern cities are exceedingly vulnerable to large nuclear weapons. The United States is probably the most vulnerable big country in the world, in terms of the fraction of the population which lives in large cities. Interconnecting blast shelters and perhaps ballistic missile defense systems are the only means I can see for decreasing the vulnerability of cities by very big factors.

The cost of fallout shelters for the United States population has been estimated at about \$3 to \$5 billion. Estimates of the cost of a complete system of 100-psi interconnecting blast shelters for areas of very high population density plus blast resistant fallout shelters for the rest of the population run to a few tens of billions of dollars. Extensive post-attack recovery system costs appear to be roughly the same as the costs of the shelters themselves.

Looking somewhat further into the future, I believe that a reversal of the current trends toward urbanization, to disperse both the population and industry, will be the most effective way of decreasing by large factors the leverage which a few large bombs can apply against a country. Modern technology is capable of things that we used to think not very long ago were fantastic. I believe we should slowly put it to work on dispersal, reliable communications and rapid economical, large-scale transportation. I see no fundamental reason why the majority of the country's personnel and material transportation system could not be underground and also serve as the major part of a blast shelter system for use in emergencies.

Obviously any national or international dispersal plans will take a long, long time to carry out; but I cannot see how else to cope with the prospects for control of a very large number of people by very few who have in their possession the incredibly destructive power of even a small number of nuclear explosives.

I see mountains of work to be done on these problems. I also see little which I believe to be of greater importance to us as individuals and to humanity as a whole. Perhaps some of the measures I have referred to will turn out not to make good sense; but I will be far happier to see vigorous work going on on more of them and fewer less heated emotional arguments which address themselves to what we should not do rather than to what we should do.

Dr. Weinberg: Thank you very much, Dr. Taylor. I want to thank you particularly for setting such a sterling example for the other panelists in holding to your time so accurately.

Opening the discussion by the opposition is Professor Tom T. Stonier, Associate Professor of Biology at Manhattan College. Professor Stonier received his Ph.D. in plant physiology at Yale University in 1955. He is well known to many of our ANS members since he spent several years as a research associate at Brookhaven as well as at the Rockefeller Institute before joining Manhattan College. He has published a number of papers on the problems of normal and abnormal growth of plants.

Professor Stonier has for several years concerned himself also with broad questions of public policy; for example, he is a member of the board of directors and secretary of "Scientists on Survival" and was conference chairman of the third annual Congress of Scientists on Survival. He has written about and presented testimony before Congress on the effects of nuclear weapons. Professor Stonier has just published a book, Nuclear Disaster, which presents an analysis of thermonuclear war. About this book, critics as wide apart as Bertrand Russell and Herman Kahn seem to agree. Said Bertrand Russell, and I quote, "I admire the judicious and scientific weighting of evidence and the careful absence of overstatement"; and Herman Kahn said, "A careful and creative treatment, the best account of the after-effects of nuclear war available to the general public." I consider it to be a feat indeed to write a book on so controversial a subject that still merits such praise from both Lord Russell and Herman Kahn. It is therefore indeed a pleasure to welcome Professor Stonier to present his views.

Professor Stonier: I would like to begin by stating the basic points of view which I bring to the problem, and then I would like to explain why I have very serious trepidations about the kind of shelter program that has been proposed by the Project Harbor study. Basically I believe that nuclear war is a real possibility. On the other hand, I do not believe that nuclear war is inevitable. I am not a professional pacifist; I do not believe in unilateral disarmament; but I do feel that a continued escalation of the arms race also constitutes a dead end and one which in fact only lessens our security, not increases it.

I am not opposed to all forms of civil defense; however, I am against freezing ourselves into a fixed formula for coping with an extremely complex problem. The problems of survival confronting a society faced with a nuclear attack are difficult to assess for a variety of reasons: There are many technical uncertainties, and, as Dr. Weinberg just pointed out, there are also many nontechnical value judgments that are associated with evaluating any civil defense program. One thing that Dr. Taylor and I agree about (one of several) is that nuclear war would constitute the greatest destruction in recorded history, perhaps throughout all of the history of mankind. To put it into perspective, I'll talk about a weapon somewhat smaller than Dr. Taylor: a 20-megaton weapon exploded over New York City or on New York City (for a variety of reasons the figures come out about the same). The mortalities produced by such a detonation would be roughly 10 times the number of battle deaths that the United States has suffered throughout its history from the American Revolution to Vietnam!

In the Project Harbor report there are a number of statements with which I am very much in agreement. The need for the establishment of a postattack operation developments group, for example, to serve as a pilot study and operations evaluation group. And the need for better understanding of the relationship between survival and recovery. Also, at one point the statement is made that one should deplore the tendency to create a model shelter program with an operational system. In general, however, I feel that the analyses have been in the past and continue to be at present woefully inadequate. This is particularly true in the area of long-term survival.

For example, there is a tendency to confuse, when one is talking about recovery, what people can do following a disaster with what they will do. The half empty lifeboats around the Titanic picked up only 13 out of the 1600 men, women, and children in the water. In fact, only one of the 18 boats even made the effort to save the people in the water. In the other boats the demoralized state caused the survivors to succumb to an irrational fear. Every suggestion to turn around was countered with: "We will only be swamped; it is no use."

There is a tendency in these civil defense analyses to ignore factors that cannot be plugged into a computer. This was particularly true during the early stages of the economic analyses which ignored items like transportation, communications, banking, and other coordinating factors in our economy. This is somewhat better in Project Harbor: It mentions, for example, that petroleum may be the "Achilles heel." Yet there is still a tendency to look at problems, or potential problems, out of context. There is no understanding of synergistic effects. And there is a tendency to apply simple engineering solutions to complex problems.

In fact, if I were to sum up in a single statement what bothers me about a shelter program, it is that I consider it equivalent to another engineering solution to a complex problem, namely, the Maginot Line, which the French built at considerable expense to solve the problem of how to prevent the Germans from invading France again. The Maginot Line provided some defense. There is no question of that. But it was inadequate against a determined enemy. The failure of the Maginot Line was not that it didn't extend across to the English Channel, but rather its failure was that it was an extension of the trench warfare of World War I and was not equipped to deal with the new military technology which was developing between the two wars, particularly air warfare and parachute troops.

Similarly, the shelter program was psychologically derived from the British civil defense program of World War II. And I am stressing the fact that it is the British experience because it certainly wouldn't have come out of the German one. The German experience in World War II started when cities were scientifically raided in July of 1943. The first city was Hamburg.

Before talking about Hamburg, I just want to point out that Project Harbor at one point says that present fallout shelters, the so-called class IV shelters, have no specific provision for blast or fire resistance but do not increase the danger from these hazards. But the Hamburg experience showed that the worst possible place for a population to be in a city that is on fire is to huddle in the basements of buildings. Now the Hamburg experience was as follows: 60,000 people were killed, most of them in basement shelters. Many of these shelters had been reinforced with timbers to resist blast effects. The fire raid produced a conflagration which within twenty minutes involved about 4.5 square miles. The pillar of burning gases rose 2-1/2 miles. Some of the RAF planes that got caught in it were flipped over. The temperatures according to the strategic bombing survey went up to 800°C (over 1400°F). But I have seen German documents which, in view of some experimental data, would make more sense; and according to them, 1400°C was reached a half an hour after the mass fires had coalesced. These extremely high temperatures lasted for five hours. It was only after six hours that they dropped to 800°C, and after 10 hours the air temperature was still well over 200°C. In some instances where shelters had been covered with rubble, the heat inside the shelter was so great that when they were opened ten days later the influx of fresh air caused the shelter contents to burst into flame.

Of the 60,000 people that died in that particular event, 70% died of carbon monoxide poisoning. The people that escaped were primarily people who got out of the area or into the canals before the fires coalesced. The ones who stayed in the basement shelters perished. I might reiterate that a 20-megaton weapon exploded in the air on a very clear day produces enough heat to ignite the clothing of a person standing 18 miles from the bomb. A radius of 18 miles involves an area of about 1000 square miles. The biggest forest fire on the continental United States in the last 50 years was less than 500 square miles, and it took many days to burn.

I would like to make a second point and that relates to long-term effects. Let me give you one example of the kind of ecological imbalances that are likely to occur: In 1939 a wind storm swept across Colorado and knocked over many of the gigantic, beautiful Engelmann spruces. This was

a sad event for the human population but was a great boon for the Engelmann spruce bark beetles, who then lived on these trees (which still had the roots down in the ground and were alive), and built up immense beetle populations which by 1942 had consumed the wind-thrown timber. They then migrated out into the healthy trees and although the beetle mortality was greatly increased (the first wave would be demolished, then the second wave; however, the third wave might be successful because the tree had been sufficiently weakened), over the next six years 16 times more timber was destroyed by the bark beetles than had been destroyed by fires during the previous thirty years in the Rocky Mountain states. Now if one were to sit down and try to figure out the most ingenious way to turn a forest over to bark beetles, one couldn't do better than to expose it to the kind of fallout fields that could be expected after a nuclear war. The radiation would weaken the trees but not kill them (it would kill some). It would eliminate the chief predators, the woodpeckers; and although it would damage the beetle population, a beetle population can recover at a rate of 500 to 1 in a single generation under optimum conditions. Such optimum conditions would be created by the preferred food supply of radiation-sickened trees.

Another point that I would like to bring out in terms of long-term effects relates to the year 1816: It is known in folklore as the year without a summer. It snowed in July in New England, crop failure was total throughout the northern United States and Scandinavia, and the reason in all likelihood was the 1815 eruption of Mount Tamboro, a volcano in Indonesia which threw up immense quantities of dust. W. J. Humphreys, a meteorological physicist for the United States Weather Bureau, is one of the chief proponents of the idea that an ice age is initiated by the reflection of solar energy by small particles in the stratosphere. Because of the shortness of time (but I would be delighted to go into a more detailed discussion afterwards),² if one makes a calculation as to how much dust might be thrown up by, let us say, one hundred 20-megaton ground bursts, one begins to feel very uncomfortable. Project Harbor talks about a 3000-megaton attack against the United States, so the total is

²See Nuclear Disaster, pp. 138-141.

presumably 6000 megatons if one includes both sides (it may be more). I am not saying that an ice age is probable. All I am saying is that it is the kind of disturbance in nature that one cannot simply ignore.

This brings me then to the last point which is that the Maginot Line created a response in the German high command, viz., how can one overcome the Maginot Line. That the Germans were eminently successful in neutralizing the Maginot Line is a matter of historical record. A civil defense program is also most likely to incur a certain response from a determined enemy. This response might very well be that instead of plastering the country with 3000 megatons he will do so with 10,000 megatons. And if the attack becomes more massive, then we will increase the reverberations upon nature. Under these circumstances it may well be that as a result of having engaged in a program which will run many many tens of billions of dollars, the long-term survival rate actually goes down instead of up.

I think that our energies are better devoted in other directions.

Dr. Weinberg: Thank you very much, Professor Stonier. Our second speaker on behalf of the opposition will be David F. Cavers, the Fessenden Professor of Law at the Harvard Law School and former Associate Dean of the Harvard Law School. Professor Cavers, originally from Buffalo, New York, is a distinguished lawyer, having practiced in New York City as well as serving on the law faculties at Duke, at Yale, at Chicago, and at West Virginia before receiving his present appointment at Harvard. He has had many contacts with the federal government; for example, during World War II he was an associate general counsel in the Office of Price Administration. And from 1943 to 1951 he was a member of the Research Advisory Board of the Committee for Economic Development. Professor Cavers is well known to members of the American Nuclear Society because of his interest in atomic energy legal regulation. He was a member of the Bar Association's Special Committee on Atomic Energy, and he comes to Gatlinburg between appearances before the Joint Committee on Atomic Energy to discuss the Price-Anderson Atomic Energy Indemnification Act. Professor Cavers' interest in civil defense began with a series of articles on problems of legal planning for protection of government and economic activities against the risk of atomic war. With the growth of nuclear weaponry, Professor Cavers became convinced of the futility of much of the planning he had been advocating,

and his many recent articles have been directed toward the question of arms control. I first met Professor Cavers when both of us attended the Third Pugwash Conference in Kitzbühel, Austria. He is a persuasive speaker, and it is a great privilege to present him to you now. Professor Cavers.

Professor Cavers: Mr. Chairman, members of the panel, ladies, and gentlemen. A massive civil defense program could be designed for one of two purposes--or both.

One purpose would be to protect our people against nuclear retaliation by whatever Soviet forces survived an American first strike. Even if the program were good for that purpose, I wouldn't like it.

The other purpose would be to hold down our losses as the victim of a Soviet nuclear attack. Surely it is plain that the USSR does not want to attack us now. I see little reason to suppose that they will want to attack us in the future; unlike the Chinese, the Soviets recognize the price of nuclear war. However, if they ever did decide to pay that price, I submit it would be because they believed they could destroy us, not temporarily as a military force but for all time as a great people. If we are pessimistic enough to want a large-scale civil defense program, our assumptions concerning the attack it would have to meet should be equally pessimistic.

Project Harbor--which I shall call "PH"--plans by the mid-70's to protect against an antipopulation attack of only 3000 mt. I submit that that assumption is unrealistic. The very fact that our defense was scaled on that assumption would guarantee its inadequacy. If we can take 3000 mt and still come back, then the Soviets won't start a nuclear war unless they can deliver much more than that. Can we doubt that they could deliver many times 3000 mt by the mid-70's, if not sooner?

In civil defense programs there is a paradox characteristic of strategic planning--great pessimism about the enemy's intentions; great optimism about the consequences of a military showdown--provided, of course, big enough appropriations have been voted and directed to the branch of the services the strategists favor.

I should prefer to see our optimism directed to the development of relations with the Communist states that will lead to a decent world order

and not to Armageddon. We would do well to be pessimistic about the prospects of buying permanent peace or security by more military hardware and a network of holes in the ground. In contrast, PH radiates a bland optimism. At least I find this in the Summary of this anthology of panel reports.

First, PH's cost estimates. In the Summary, these are sketchy. Their optimism rivals the calculations of a young couple trying to convince their parents that two can live as cheaply as one. First, PH proposes Class I blast and fire shelters for cities of 250,000 or more, a total of 75,000,000 people. Everybody else would get only fallout shelters. A Class I shelter for 1000 people, protected against 100 psi, having a radiation protection factor of 10,000, with essential ventilating and other facilities, is said to cost only \$175,000. A 100-space shelter would cost \$300 per space. These are bargain basement prices. PH still clings to OCD's conception of a shelter space as 10 square feet. Envisage a 9-x-12-ft rug. It covers almost 11 shelter spaces. Imagine spending two weeks on it with 10 other people.

PH estimates the total cost of these Class I shelters at \$20 billion. The panel reports provided no hard data to sustain this figure which is far below most previous estimates, some of which go to \$100 billion or more. It expressly excludes the cost of land and the dislocation of utilities. Blast shelters must be reachable in 15 minutes or so and therefore must cluster where land costs are highest.

But imagine building expensive blast shelters for the 75,000,000 people in the larger cities and telling everybody else: You get fallout shelters. No administration would get by with this, especially since, as PH assumes, Uncle Sam is paying the bill. About 120,000,000 people now live in 211 standard metropolitan areas. Sheer civic pride would lead to demands for coverage by, say, 100,000,000 or so of these people.

PH recognizes that building shelters alone is not enough. The more successful the shelters are, the more people there would be to feed and shelter after the attack. The study's assumption of an 80% survival rate after a 3000 mt-attack calls for a vast apparatus of storage facilities, shielded inventories of all sorts, means of transporting them, and means of restoring the electric power on which urban, suburban, and even rural

life now depends. PH suggests that "it would be reasonable to spend more on recovery measures than on the shelters themselves, though probably not twice as much."

All right, let's be conservative. Let's assume \$50 billion for shelters and \$75 billion for recovery measures. Maybe, if the enemy were content with 3000 mt, we would lose a mere 40,000,000 people, as PH suggests.

PH gives no time schedule for its program. It does propose a prototype system: an urban, nonurban, and near-target system, "on a small but realistic basis." It advises against a crash program. Let's take two to three years for the small prototype system and then go on to the real job: spending \$125 billion. Should we do it in five years, say, \$5 billion the first year, \$15 the second, \$25 the third, \$35 the fourth, and \$45 the fifth; in other words, rising close to the level of all our present defense spending?

This is fantastic. This would have a terrific inflationary wallop, not to mention its impact abroad. Construction costs soon would soar. Suppose then we stretch the program out--say, to ten years and add \$25 billion more for rising costs. This might produce a schedule rising to \$20 billion in the fifth year and continuing at that level for the next four years, dropping to \$15 billion in the tenth. By 1977 we would have covered much of the country with a blast shelter system and supporting infra-structure--all by then probably unwanted or obsolescent.

You may think a \$20-billion-a-year program isn't big. It equals nearly one-third the total amount of construction of every sort in the United States in the boom year 1963. All public construction--streets, highways, schools, hospitals, bridges, dams, etc.--in that year came to less than \$19 billion.

Second, PH's personnel estimates. How do we staff this monster? For "management and operation," PH sees a "federal cadre of about 30,000 professional people." Presumably they would have a supporting staff. Professionals are to plan, as well as to operate, the system. But surely a \$20-billion-a-year program to build shelters and intricate new utilities and other postattack facilities in every metropolitan area of any consequence would require a much larger staff. One panel report set the figure at 50,000 professionals and considered that number far short of the number

needed. Moreover, the civil and industrial engineers needed for the building wouldn't be the proper types to run the show, once built.

For this, PH proposes a Civilian Reserve Corps, a grass-roots organization. They would have to get people into the shelters, keep them there, feed and discipline them, and prepare them for the life amid the rubble. This reserve would have to be large. Shelter capacities would range from 100 to 1000. Suppose the average were 500. To train 500 people to scuttle to their shelter and to organize, command, feed, and comfort them there would call for a reserve staff of at least 8 per shelter, to take a PH panel's minimum figure. Moreover, urban life requires many more shelter spaces than there are people. Two-hundred-fifty-thousand blast shelters for, say, 100,000,000 would require a reserve staff of at least two million. One panel suggests three. At least another quarter million would be needed for the fallout shelter areas.

But where are we to get the men to man the cadres of professionals? Just how attractive would an able engineer find a ten-year career with the program? I can see openings aplenty for second- and third-rate lawyers. Now who would volunteer for the Civil Defense Reserves? I shall touch on this later, time permitting.

Third, postattack program. PH appears to assume a short war, which of course we win. It doubts a surprise attack; in fact, it dallies with the idea of strategic evacuation as tensions escalate, a favorite notion of its adviser, the Hudson Institute. It rejects my pet horror--nuclear guerrilla war in which enemy survivors either don't know they're licked or don't give a damn and simply keep on doing their worst with such nuclear weapons and means of delivery as they have left.

The PH planners have taken the recovery problem more seriously than many civil defense thinkers. On top of the biological and ecological troubles, the economic and political problems seem to me all but overwhelming.

[Here the PH Summary attributes obdurate optimism to its advisers: "As a principle the panel warns against resorting to disaster socialism unless truly necessary.... The panel believes that government interference with the spontaneous recuperative process of a free economy should be held to a minimum. In areas where some sort of price control is needed, the

panel urges that it be carried out by currency and credit control rather than out-right price determination by fiat."

The panel, however, does see the need for "disaster socialism" in the devastated areas, and its "currency and credit control" would be drastic, in effect a scheme for rationing money. In my view the panel grossly underestimates the effect of destroying our cities, even if--perhaps especially if--shelters did protect most city populations and no great plagues swept off the hordes of refugees. Most past values would be meaningless. Our currency and credit system would be in shambles. Our credit economy is a delicate, complex instrument. The impact of nuclear war would be like pounding that instrument with a hammer.

Contrast the situation with that after World War II. Apart from greater destruction and the effects of contamination, one major distinction remains: No nation would be left that could play the role of the United States. Salvaging a devastated Northern Hemisphere would be much too big a task for the Southern--or for Japan if, ironically, it alone of the major powers escaped the holocaust.]

Fourth, the effect of selling the PH plan. The prospect of a world in which all the major nations were desperately struggling for survival, not against each other but against famine, disease, and destitution, is so grim that I am convinced we should focus our efforts not on trying to see how many of our people we can save in a nuclear war but how we can save all of them from a nuclear war. One sound tactic to that end is not to start a new round of the arms race by combining an antimissile missile program with a massive civil defense program.

Consider how the PH program could be sold to the American people. On this point, the PH Summary and panel are hyper-optimistic. Except for two spasms of concern following two international crises, the American public and Congress have shown monumental indifference to actual and proposed civil defense programs. Compared to PH, these have been modest indeed. However, the two responses do show clearly what alone can arouse public concern. It is fear--fear of an impending nuclear war.

How is any administration going to build up and maintain the public's fear to the pitch needed to secure continuing public support and annual appropriations for a \$150 billion, twelve-year program? This is a job for

a totalitarian state. It requires keeping anxieties tense, stirring up one crisis after another, and finding nuclear threats everywhere. To relax the pressure for six months or a year would be too risky. A detente would be disastrous. Positive moves for peace would undercut the program.

Moreover, this buildup of tension would have to be brought home wherever those quarter-million blast shelters were to be built. People who had to be conditioned to rush to the shelters at first warning would have to be kept convinced of their families' peril.

[The PTA's, the hospital boards, and the urban redevelopers would have to be kept resigned to the fact that federal money could not be squandered on schools, hospitals, and new housing. Business concerns would have to join happily in developing postattack facilities.]

Heavy pressure would be needed to enlist the professional staff and civilian reserve of nearly two million and a half. Who would be easiest to enlist? Obviously John Birch Society and Minute Men types. Their roles would provide a taste of authority. They would welcome the chance to preach their sanguinary world view and to stamp out dissent from it.

[To build up the public's fears to the desired level is to ^{now} sew the dragon's teeth. In time the fears would demand relief in action. Once we believe our lives really are at the mercy of an ever-threatening enemy, insistence that we have done with suspense and have at them would either trigger that response or else create such a risk of our doing so that the other side would decide it could no longer afford to wait. One PH panel predicts that a civil defense program of \$10 billion per year or more would be viewed by the Soviets as a "military threat," a "warlike and provocative act."

Not only our adversaries would be alarmed. The involuntary association of our allies in our fate would make them anxious as our buildup continued. Lacking effective defenses, they might feel forced to make their peace with the Communist Bloc as best they could.]

Finally, if we were carrying a massive shelter program through to completion, I should grow distrustful of our government. Given the boasts and warnings needed to keep that program rolling, I suspect noses around the Pentagon and the White House would grow harder and more hawklike.

[Would it then be surprising if the hawk chose to strike first?]

Happily, I think this nightmare is only a nightmare. I don't believe the United States has either the will or the capability of frightening the American people and the Congress into adopting a program like PH and staying with it. I think the worst we have to fear is that, if the antimissile missile gamble is accepted, we shall see another pseudo-shelter program adopted. It will cost a lot of money that could be better used elsewhere; it wouldn't do much good in a nuclear war; but at least it wouldn't be as likely as a large-scale program to make such a war probable.

Dr. Weinberg: Thank you very much, Professor Cavers. I might make a suggestion to members of the panel that, inasmuch as the temperature both of the room and of the discussion seems to be increasing, it might be in the interest of all of us to take our coats off, so why don't we do that.

Our final speaker is Eugene P. Wigner. Professor Wigner needs no introduction to members of the American Nuclear Society, being a Fellow of our Society. His profound and beneficent influence on our attempts to harness the promise of the atom for peaceful, constructive purposes is attested by the many references to his work on reactor theory and reactor engineering at so many sessions of our Society's meeting here in Gatlinburg. Professor Wigner's interest in civil defense, which had been growing gradually, came to a head in 1963 when he directed the so-called Harbor Study on civil defense--the one referred to as PH by Professor Cavers--which was sponsored by the National Academy of Sciences. Professor Wigner has, during the past year, been director of the Oak Ridge National Laboratory's civil defense study project. It is therefore a particular pleasure for me to introduce to you one of my better-known employees and Nobel Prize winner, Professor Eugene P. Wigner.

Professor Wigner: Thank you very much, Dr. Weinberg. The opinions which I will give will be also, as Dr. Taylor's, just mine. They are mine now, but I hope at the end they will be yours also.

I am very much tempted to answer the two critics (and two very eloquent critics) of the civil defense program. Very much tempted but perhaps I should not do so, but I should stick to my prepared statement.

Perhaps I do say that I am a little bit reminded of the case when somebody was accused of a terrible crime, murdering somebody, dragging him through the woods with the bleeding limbs and torturing him at the end to death. The state attorney told a stirring story describing most powerfully and eloquently the base nature of the crime. Everyone was deeply moved. The accused produced at the end the alleged victim. He was in good health and he didn't remember any of these events, but it was very difficult to efface the effect of the powerful and strong speech of the state attorney who described so well the misdeed which had happened and for which it was hard to accept that it should go unpunished. Let me not continue on this. Let me start by saying that Dr. Taylor proposed seven means to decrease the likelihood of an armed conflict among nations and of diminishing the effects of such a conflict if it should nevertheless break out. I am in favor of every measure which will preserve the peace of our country, and also for other countries, as I am sure all members of this gathering are. I am also in favor of alleviating the suffering which a war would cause if it should nevertheless break out. My remarks will be directed principally toward civil defense only because this is the principal subject of our panel and because I have studied this more closely and more intensively than any of the other measures mentioned by Dr. Taylor.

The preceding remarks already give the two objectives of civil defense which I conceive: To render a conflict less likely and to provide protection for our people in case of a conflict. There is, I believe, general agreement that civil defense--though by no means a panacea for all ills of the world--does provide some measure of protection in case of a conflict. Dr. Stonier's book, Nuclear Disaster, gives several indications therefor. It mentions, in particular, that two feet of ground or concrete above at the shelter will prevent the heat from entering the shelter. I shall return to this question later.

I sense more disagreement in general with the proposition that the protection which civil defense provides also decreases the chances for a conflict. In fact, there appears to be a tendency to claim that by providing protection against the effects of a nuclear war we render such a war more likely. [Even further, some people imply that to advocate civil defense is warmongering.] This attitude is held, of course, only

by a small minority, and the effect of civil defense on the preservation of peace is recognized for instance, as a matter of course, by Eugene Rabinowitch, who said, "The fourth," that is civil defense, "was--and remains--the only fully effective means of reducing the consequences--and thus the likelihood--of an atomic attack, if rational attempts to make it impossible prove futile." Thus Rabinowitch equated the reduction of the consequences of an attack with the reduction of the likelihood thereof.

To me it also seems that the large losses which can be inflicted on our population constitute a great menace to peace. Our vulnerability virtually invites an attack--which would be so effective--or at least it invites threats of an attack to force our defenses back step by step. This would be more difficult if we could protect our people better, and the temptation to do it would then decrease. Few try to do the impossible or even the very difficult. Thus the number of attempts to rob the New York banks dropped suddenly when the protection of their vaults was strengthened. Similarly, opposing governments would be less tempted to exact repeated concessions from us if we were not quite so vulnerable. Politics is the science of the possible, and history teaches us that weakness invites aggression. I believe the last war would have been averted had the West not tried to appease the Nazi government but had shown resolve and foresight.

I have heard the counterargument that the removal of the temptation to attack us would make our government bolder so that the less aggressive attitude of opponent governments would be compensated by a more aggressive attitude of our own. This seems to me to be most unlikely in view of the great devastation which a nuclear war would cause under any conditions. In addition, the counterargument assumes that our government has certain objectives or desires which can be achieved by aggression, i.e., that it wants to extend its rule. This, however, is clearly not the case. I cannot imagine the case which Professor Cavers conceived, that we protect our people against retaliation. We did not start a nuclear war when we had every possible provocation by the blockade of Berlin, and as we learned from Murphy's book the existence of our nuclear weapons was never mentioned in the State Department at that time. We had a monopoly

of them. In fact our government would be terribly embarrassed if an opportunity arose to extend our rule significantly by a large nation offering to join the Union. It is massively important in my opinion to realize that the situation in this regard is not at all symmetric between our country and the USSR. Much less is it symmetric with respect to China. It is in consonance with this that all our conflicts with the USSR since the world war were initiated by some move which had, as a purpose, the extension of the rule of the USSR and that our role was either to acquiesce, as in the case of Czechoslovakia or Hungary, or to resist, as in the case of Berlin and Korea. It seems to me, therefore, that the arguments based on the symmetry of the relation between East and West are based on a non-existent symmetry, on a symmetry that is not valid even in strong interactions. Since our government has no desire to extend its rule, its lower vulnerability will not lead to provocative behavior, much less to conflict.

Let me now come to the second point, that of the actual methods of protection against the effects of a nuclear war. This is an important problem not only because a war remains possible but also because, and perhaps principally because, the effect of civil defense measures in dissuading aggression is in very direct relation to their physical effectiveness. At the same time, this is a technical problem which evidently requires extensive study. Also, as in most cases, the first solution which occurs to one is not the best. Finally, as in all technical problems which deserve this name, it is easy to prove that they are unsolvable by pointing to a particular apparent solution which, upon investigation, turns out to be inadequate. It is easy to show that no bicycle can work, and, of course, no technical problem was ever solved by anyone who was opposed to its being solved. Hence the fact that the opponents of civil defense can envisage no such defense does not prove that all civil defense measures have to remain ineffectual.

If we come to the methods and effectiveness of civil defense measures, the first point one has to make is that no one has envisaged a fully effective system. Similarly, to use Kennedy's simile, no insurance really compensates for the loss suffered and, similarly, no hospital cures all patients. Neither of these two statements means that insurance or hospitals are of no value. Their value does depend, however, on their effectiveness.

The civil defense system which we envisage implies at least fallout protection for everyone. This is relatively inexpensive and protects against that effect of nuclear weapons which can be most widespread: radiation from fission products. However, the effectiveness of civil defense preparations can be very much increased by two additional measures, one of which must be, obviously, protection from the blast and heat effects in reasonable target areas.

For this purpose we are studying a tunnel-grid system, which is an array of tunnels: two sets of tunnels perpendicular to each other. Parallel avenues of the tunnel grid system would be at a distance of about one mile from each other at a smaller distance in densely populated areas. There would be enough entrances so that an entrance can be reached in about 10 minutes' walking time from any point on a street. The tunnels would be at least a couple of feet underground; they would consist of 8- or 10-foot diameter concrete tubes. This would provide a blast resistance of well over 100 psi and, as has been mentioned also by Dr. Stonier in his book, also protection against the heat from the explosion and from possible fires and from nuclear radiation.

This is a very brief description of the shelters which were actually first proposed by Professor Harrenstien of the University of Arizona. The system has several advantages, principally based on the fact that it provides a system of communications throughout the community in which it is established. Hence, the original congestion in congested areas, that is, principally the centers of the cities in daytime, where space is at a premium, can be relieved under sheltered conditions. Families can be united, and each person walking through the tunnels to his assigned place can join his family. Medical and other services can be provided not only in the regions adjacent to medical centers. As a result of the relatively high blast resistance, we estimate that if the population has time to spread out from the congested areas so that the distribution becomes reasonably uniform throughout each shelter system, the number of casualties would be about 15 million over the whole country if the whole present nuclear rocket capability of the USSR is used in an antipopulation attack. You will note that this is a much lower figure than given in the Harbor Report, as this is the result of further study and better methods of

protection. The number of casualties could be much higher, though, if the explosions find a large number of people in the congested areas and much smaller if--as is likely--most of the enemy capability were used against military installations.

[Blast resistant shelters in cities can play a significant peacetime role in meeting some of the acute problems precipitated by our rapid urbanization. The tunnel-grid system can carry utilities, such as telephone and electric lines. More importantly, it can help relieve traffic either by providing all-weather pedestrian walkways or by accommodating rapid transit trains. Its potential usefulness in this regard is perhaps best demonstrated by the fact that several cities are installing or plan to install tunnels to relieve their traffic problems quite independently of the requirements of civil defense. Let me emphasize, however, that the details of the system have not been fully worked out, and we shall be neither surprised nor discouraged if we encounter new technical problems.]

The installation of blast shelters is the first and most obvious supplement to the present fallout shelter program. Preparations for economic and societal recovery form the second supplement. These were the principal subject of Project Harbor, a study organized the fall of 1963 by the National Academy of Sciences. This study found much comfort in the magnitude of our resources, in particular of our food stockpiles. It felt serious apprehensions because of the great interdependence in our economy. Let me not review the findings of this study in detail; a summary is available in the literature. Incidentally, the study has a good deal to say also about ecological problems.]

I would like to say, in conclusion, a few words about the relation of civil defense to the other measures mentioned by Dr. Taylor. The measures mentioned by Dr. Taylor can be divided into two classes: short-time and long-time measures. The other short-time measure which Dr. Taylor mentioned is antiballistic missile defense. We are trying to study the relation between active and civil defense measures and believe that the two can complement each other. The casualty figure I mentioned was in the absence of active measures so that active measures could further reduce it significantly. On the other hand, let me repeat that the figures take into account only the ballistic, that is rocket-carried attack.

Let me come to the last question, the relation of short-term measures, that is, of active and civil defense measures, to the long-term measures, that is, the true objectives such as the World Court, the absence of hatred, of the desire for conquest; in short, of true peace. As in other areas, the short-term measures are designed to bridge the time until the long-term measures become possible. As long as some governments wish and hope to extend their power by conquest, the long-term measures will run into one obstacle after another. The fact that Communist leaders praise the "irreconcilable hatred of capitalism" and claim that "the mere existence of imperialistic states is a menace to peace" shows that they have not yet learned to tolerate their neighbor and will not accept a World Court of supranational power. We must do all we can to further the long-term solutions, but we can not afford to ignore the present state of the world. Thank you very much.

Dr. Weinberg: Thank you very much, Professor Wigner. We now come to the direct confrontation between those on my right and those on my left. My impression is that the debate, if you could call it that, is thus far not quite met headon. The speakers on my right (on your left) seem to concern themselves much more specifically with issues that were set forth in the Project Harbor study; whereas Professor Wigner and Dr. Taylor seem to speak to the matter in rather more general fashion. And, I think therefore, I might depart a little bit from our original plan and invite from Professor Wigner and Dr. Taylor a five-minute statement, if you like, of what it was the Project Harbor report said and then in order to keep the balance exquisitely balanced I will ask for a similar five-minute statement from the gentlemen on my right. Professor Wigner, would you like to say the things that you wanted to say at the beginning of your talk but didn't?

Professor Wigner: Thank you very much. I agree with most everything Dr. Stonier said. The only problem is that he did not emphasize the point that the gruesome picture which he painted (and it is a true picture and a truly gruesome picture) applies in the case that there is no civil defense. If there is civil defense, the situation is very, very different, and it is partly for this reason that we advocate a strong civil defense.

Let me go to a few specific cases in which he did refer to the Harbor Report. He said that people will act in an unsocial, or as our social scientists say, in an antisocial fashion, and mentioned the Titanic disaster. The Titanic disaster was an awful disaster; and people, many people, behaved antisocially. I could quote more examples (one very, very tragic one very recently in Oak Ridge) where people behaved very, very socially. And it is possible to envoke in people the instinct to help their neighbor rather than to go by them carelessly and care only for themselves. This is one of the objectives which we want to study, and we do know of a number of conditions which make for this antisocial behavior as it has been described and as it applies very strongly in the case of the Titanic.

As to the Maginot Line, I do not agree with Dr. Stonier. I think the Maginot Line mentality induced the French to be content, close their eyes, and not to try new measures, not to keep up with the development of the world. Similarly, not to engage in civil defense is the Maginot Line mentality. We have a certain retaliatory force. This is all. We don't want to do anything else. This is what reminds me of the Maginot Line. Let me not get into the Hamburg disaster, where I differ perhaps from Dr. Stonier; but, as I mentioned, two feet earth cover would prevent the heat from entering and in most cases the cover would be very much thicker. I come to that in a minute.

As far as I could understand Dr. Cavers, he mainly criticized our cost estimates. I am in the very favorable position that I received yesterday an engineering design of the company, Holmes and Narver, on the West Coast, for a 5-x-5-mile region of Detroit for which they estimated the costs.³ Now Holmes and Narver is a contracting firm, and the estimate is made on the basis of present-day art for an occupation time of four weeks and with ample facilities, in fact, with facilities which they occasionally describe as unnecessarily luxurious; but perhaps we should not debate whether they are unnecessary or not unnecessary. Certainly the amount of water which they have is four times greater than the amount of water stipulated by the Office of Civil Defense. The cost is in fact larger than the cost of the Harbor Report; but, as I emphasized, it is a full cost. It is so large that it amounts to 18% of the construction companies' present level. Now, I do think that the construction

³Donald T. Robbins and David L. Narver, Jr., "Engineering Study for Tunnel-Grid Blast Shelter Concept for a Portion of Detroit, Michigan," ORNL-TM-1223 (June 1965).

companies could extend their facilities by 18%, and I don't think that this would lead to a significant dislocation.

Dr. Weinberg: Which cost was 18%?

Professor Wigner: The construction of the shelter.

Dr. Weinberg: For the 5-x-5?

Professor Wigner: No, for the 75,000,000 people living in cities of more than 200,000 people. Dr. Cavers said that the cadre is too small (50,000 people). Well I don't know whether it is too small, but we have an army of about 2-1/2 million people. Suppose that the Harbor Report was in error--which I don't believe because after all they thought it over carefully and did not arrive at it from the top of their heads. But suppose the number has to be multiplied by 2. Well, that would mean that in addition to the 2-1/2 million people in the armed forces we would also have a 100,000-person cadre of civil defenders. I can't, frankly, get terribly excited about it.

Dr. Cavers also mentioned that the program can be implemented only by instilling fear into the people. I think descriptions of the disaster that would befall the country if we had no civil defense is much more likely to instill fear into ourselves than a reasonably executed program which will defend us. I just can't see that the discussion of the unbelievable disaster that would befall us if we had no civil defense is not instilling fear; whereas a program which is reasonable, conducted in a professional way does instill fear. [It is in consonance with this that, so far, the horror stories come from opponents of the shelter program. Am I right to infer that Professor Cavers is just as much against the actual scare stories which we hear every day from opponents of civil defense as he is against the hypothetical scare stories which may be told one day by the advocates of the shelter program?]

The final point of Dr. Cavers was that the matter won't be done anyway. Well, I think perhaps he is right and perhaps he even contributes to it. But I doubt that it is right to claim that the world as it is is the best world, and what we should be interested in is not what will happen but what we think should happen. Thank you very much.

Dr. Weinberg: Thank you very much, Dr. Wigner. Since Dr. Wigner has taken 7-1/2 minutes instead of 5 minutes, I think it is only fair for me to give an equal time to our friends on the right-hand side of the table.

Professor Cavers: If our populace were composed of people of the temperament and analytical powers of Dr. Wigner, perhaps the continuing successive doses of fear that seem to me necessary to get a program of the kind he has described off the ground wouldn't be necessary. But I point to the facts--what has occurred in the past. I see little reason to suppose that other modes of persuasion are going to be more effective with respect to the kind of program that he has in mind. I, of course, have had no opportunity to consider the very interesting tunnel configuration which he has in mind or the engineering report which has been provided for it. I hope this will be available publicly.

I think there is a problem here which has been better stated than I can do by Doctors Wiesner and York in their Scientific American article in October 1964, where they say:

"Even with large numbers of blast shelters built and evenly distributed throughout the metropolitan community, people would soon realize that shelters alone are not enough. Accidental alarms, even in tautly disciplined military installations, have shown that people do not always take warnings seriously. Even if they did, a 15-minute early warning provides less than enough time to seal the population in a shelter. Accordingly the logical next step is then to live in and work in blast shelters, leading to still further disruption and distortion of civilization. There is no logical termination of the line of reasoning that starts in belief in the usefulness of fallout shelters. The logic of this attempt to solve the problem of national security leads to a diverging series of even more grotesque measures."

I think that there are other ways to pursue our security than by measures of this sort which over a long period of time would, it seems to me, inevitably build up and preserve the tensions and the fears that have characterized our past twenty years.

Dr. Weinberg: Dr. Stonier?

Professor Stonier: Yes, I would like to say a couple of things. Firstly, I don't think Professor Wigner and I are in disagreement as far as doing nothing being the answer. It is not commendable to say that you are just not going to think about the possibility of nuclear war--even to the extent of thinking seriously about a civil defense program. We should seriously think about a civil defense program. And, as I indicated, I am not opposed to all forms of civil defense. For example, I think we need to support further research and development,

and we need to support the kind of things you (Professor Wigner) are doing. I think we need to support a frank public information movement which paints the grisly picture that is likely to result from a nuclear exchange. I feel that anybody who has looked carefully at the postattack conditions, or the attack conditions themselves--if he becomes fully cognizant of all the kinds of problems which he is likely to run into--will automatically increase his chances for personal survival. And that in itself constitutes a first significant act.

If one considers the Hamburg incident, for example, one can envision the following situation: An air burst over a city with no significant local fallout. In that case, the worst thing that could happen is for people to rush down into the kind of fallout shelters that are around now. These are in the basements of buildings which are going to catch fire.

Professor Wigner: You are right.

Professor Stonier (continuing): This might not be true for the concrete tunnels which you have in mind. However, there is one thing I didn't quite catch. Are these tunnels interconnected?

Professor Wigner: Yes.

Professor Stonier: Now, what happens to a blast wave if you have a ground burst hitting at one point?

Professor Wigner: There are experiments on this, experiments carried out in England to determine what would happen if an explosion hit London and the subway tunnels. I dislike to say it because I don't believe this is conclusive, but the evidence is that the tunnels fold back and seal themselves. As I say, I am not satisfied with the evidence, but what the evidence shows is that the tunnels fold back and seal themselves.

Professor Stonier: But you have a ground shock involving an immense amount of energy. Also, as you know, energy is lost much more slowly traveling along a tunnel than it is out in the open. I can envision the serious possibility of cleaning out the whole system with one ground burst of a much smaller magnitude than would be needed otherwise.

Professor Wigner: Naturally, we thought of this. The tunnels are not straight, but they are interrupted by so-called "breaks." And at these breaks, the shock wave is also broken up and it does not penetrate further. Also, there are doors at these breaks so that this contingency--which is a

very important and a very serious one and which we want to study very much further--is not.....(interruption).....

Professor Stonier: No, well I was obviously confused. The other question I have is, you mentioned that two feet of earth which will impede the flow of heat; however, in most shelters you are going to have to do one of two things--either provide an internal oxygen supply or cool air coming in from the outside since it is the superheated air and the conduction along the shaft which is going to heat up the air in a shelter very fast. In addition, without proper ventilation in many cities in the United States.... As you know, from submarine studies and other cases, when you confine people in a limited space they produce enough heat [for it] to become physiologically intolerable within a day.

Professor Wigner: Of course, you are absolutely right; however, the cost and plans include a refrigeration system which works on cooling the air and pushing the air on the bottom of the tunnel and distributing it (60°F air) and pulling back the air on the top, the heat being deposited in water which is evaporated. Water is provided for it.

Professor Stonier: What is the source of power?

Professor Wigner: Also included in the cost are gasoline, kerosene motors. These are important points which did not escape us.

Dr. Weinberg: I perhaps think I might ask Dr. Taylor if he would like to comment for a couple of minutes and then we will have a free-for-all among the panelists. What we have had so far "ain't nothing yet." Wait a while.

Dr. Taylor: I'll try to pick out a couple of points that I am particularly concerned about. The one I guess I am most concerned about--I felt this most strongly while Dr. Cavers was talking--is that this idea that all we have to consider is various ways in which we might be subjected to an attack by the Soviet Union. I think the reason that I, until fairly recently (I'd say until about a year ago), was not concerned enough about civil defense to do anything about it was because I agreed with this idea that it seemed totally irrational that we would attack Russia and that, as long as the situation is the way it looks now, it seems very unlikely that Russia would suddenly start an all-out attack on the United States. I am worried about something else which has developed most pointedly

across the last year or two, and that is this: What happens when there are several countries (as there are today) which are capable of making very large explosions and using them in a lot of very dirty ways in which they don't announce they are going to attack? They don't attack all at once; they don't even display who is doing the attacking. The thing that had me most strongly convinced that we need a complete shelter program, including some way of protecting cities, which means some form of blast shelters, is this: I can see not just one or two, but essentially an infinite variety of ways in which even a very small number of individuals can bring pressure to bear on a country through the use of nuclear explosives. Pressure can be applied through threat of an act which is a result of only a few hundreds of many years of effort, the result of which would kill in a very short time at least 10 million people. I simply do not see any way of coping with this problem short of a simultaneous start in a very serious way of all of the measures I advocated. I cannot leave out a single one before I find out that I am in very serious trouble in trying to cope with this problem of a very small number of people applying leverage against a whole country, perhaps even the entire world.

Now, the other thing I wanted to talk about is the matter of cost. If I really believed that we could see a way clear to survival of the American system and a gradual getting back to a state of normalcy even after an attack of some tens of thousands of megatons, by spending a \$100 billion a year, and I were really sure that this is what it would cost, I would strongly advocate we do this. A \$100 billion right now is a sixth of the gross national product. If one asks where can this come from, there are a great variety of things which this country has and is building and doing which I consider perhaps reasonable but certainly as luxuries. I don't think it would cost \$100 billion a year; I think there is strong evidence that it would cost about \$10 billion per year for perhaps ten years to give us an extremely effective way of coping with these threats of destruction of a large number of people by a very few. Ten billion dollars a year is just a little bit more than the [amount Americans pay each year for the difference between a \$2000 car and the "average" car they buy.]

Professor Stonier: There are two levels the discussion has been hitting: one, of course, is the technical one itself, and then one is more nontechnical. The point I did wish to make earlier though (and which relates to the Maginot Line) is that the French closed themselves into a very stereotyped kind of position. I think a shelter program can do the same thing. Now, it is hard to tell whether it will freeze us into the kind of position that Professor Cavers indicates (a warfare state). I think there is a real danger. I don't know whether it would happen or not. But I think it is something that can not be dismissed a priori. Certainly, we saw in Germany a systematic developing of war psychology. You see, civil defense in a way appeals to the best in a man--he is protecting his family, getting ready to defend his country, and all that sort of thing... It can create a kind of a war psychosis which is analogous to when the drums start beating.

We still do not understand the forces which lead to war. I think it is a great oversimplification to consider the problems that we have in the middle of the 1960's as a question of a serious asymmetry between us and the Soviet Union. I think theirs is a society in transition just as we are. I think it is a mistake not to recognize that there are certain social dynamics changing the nature of both countries.

Dr. Weinberg: Dr. Wigner, would you like to respond?

Professor Wigner: I think what Dr. Stonier said is very, very true, and I very much agree with him, and I do think that one must watch these things very carefully. However, I do believe that the difference between Germany, which wants to have more lebensraum, you remember, and the United States, which limits immigration, is tremendous. We do not want to extend our territory; we do not want to have colonies; we want to be left alone; and this is, so to say, the motif of this country. And this is what, I think, will keep us from becoming belligerent and will keep us from embarking on adventures. And in this I have really full and complete confidence. I have seen Germany, I lived there, and I know how it was done. It was done by arousing the greed of the people. We can't arouse the greed because we are well off and happy as we are, and, in addition to that, we just don't want more people.

Dr. Weinberg: I think I will ask perhaps for the group on my right and my left to prepare, say, two more minutes of closing statement and then we will ask the audience to address questions to the panelists. Dr. Cavers, would you like to?

Professor Cavers: I have been building up a few points. The statement which Dr. Wigner has just made, I think, gives point to the concern that I have been expressing. Our basic psychology I think very properly is described by him as: "We want to be left alone." What we don't want is to have a continuous threat to our existence, which would be constantly built up by the push that would be necessary to get public support for the kind of programs that we have been considering. It is when that threat becomes intolerable that we would be getting tougher and tougher. Not because we are greedy but we want to be left alone.

Now in connection with the cost factor, I won't argue that we couldn't afford it. By practicing one form or another of austerity, such as fewer schools and hospitals and not having to purchase our cars yearly, we can afford a shelter system. But what I am emphasizing the cost factor for is to emphasize the problem of public persuasion which, it seems to me, has been wished away thus far by most of the advocates of much larger programs. We have had plenty of public education that nuclear war is a terrible thing. It isn't that people haven't been told that; it is that they don't like the kind of response which has been urged upon them as the way to meet it.

Now, Dr. Taylor's dramatic scenario is one which I suspect will be afflicting more and more people as the Soviet menace seems to be dying out. I have two comments to make on it. In the first place, it seems to me an excellent example of the pessimism I mentioned concerning other people's intentions and thinking. The other element in it is that, if we were to be the victims of the machinations of some small sinister nation or group, we would be caught, because of its very unprecedented nature, off our guard. I could not imagine getting the population into the shelters in time to meet that kind of attack. The kind of situation that alerts the population is a continued tension. This would be a bolt from the blue, and everybody would be caught unawares.

Dr. Weinberg: Eugene, would you like to say something before we ask...

Professor Wigner: I really have very little to say. I do not believe of course, that we should cut down on schools and hospitals to establish a civil defense program, and we have not cut down on schools and hospitals when we established, for instance, the space program, which is quite comparable in magnitude with the civil defense program. I never heard that we had to cut down on schools. There is perhaps one more point that I would like to bring up. To rely only on deterrence seems to me--and I am sure Dr. Stonier at least agrees with me--seems to me to be contrary to our ethics. To say that if you do something wrong we will kill 20 million innocent people is not in conformity with our ethics. It is not the way I wish this country to act. It is much better if we try to protect ourselves, minimize our losses by defensive measures, rather than by retaliation; and this is perhaps the last thing I would like to say.

Dr. Weinberg: Thank you very much. I think perhaps now we might call on members of the audience to address questions to any of the panelists. Perhaps you can rise and identify yourselves and then say to whom your question is addressed.

My name is [Dr.] George Stanfords from Argonne National Laboratory. I have, I guess it would be, a two-part question for Dr. Wigner. Towards the end of the Project Harbor Summary there is a list of ways suggested for furthering public acceptance of the civil defense program. There seems to me to be an omission from that list and I wanted to ask whether it was deliberate or an oversight. And that is no where in the list did I find the suggestion that public acceptance might be furthered by some sort of evidence that a civil defense program would be (could be or would be) tied in with progress away from the possibilities of war. Can you hear me?

Professor Wigner: No, the last five words I could not hear.

Dr. Weinberg: He was asking for evidence that civil defense could be tied in with evidence that we were trying to move away from the possibility of a war. Is that correct?

Dr. Stanfords: Right. So, my question is, was this an oversight, and, if so, do you think that acceptance of civil defense might be furthered by, for instance, advocating expenditure of an equal amount of money (like \$10 billion a year) on work such as the Arms Control and Disarmament Agency is doing? So, my question is, would you advocate such an expenditure along with a civil defense program?

Dr. Weinberg: To paraphrase the question (I think I have it correctly), do you advocate coupling expenditures for civil defense with expenditures for more positive actions in the direction of arms control on a dollar-for-dollar basis?

Professor Wigner: I would advocate work on disarmament. I think disarmament is only a manifestation of less conflict, less hatred, less antagonism between governments, and I would advocate, by all means, every possible measure which can further this purpose. I do not believe that it would be possible to do that on a dollar-for-dollar basis just as I do not believe that you can spend as much on theoretical physics as on high-energy physics. It is just not possible and not practical. But, surely, Dr. Taylor emphasized very strongly that the ultimate purpose is not civil defense. The ultimate purpose is true peace.

Dr. Weinberg: Dr. Stonier?

Professor Stonier: I would like very much to address myself to that point because I think you have hit on something terribly important. As I view the problem, there is a tremendous gap between our physical technology, which is very advanced, and our social technology, which is still coping with the equivalent of the phlogiston theory. What we need to do is spend \$10 billion a year to set up, for example, a National Institute of Social Studies along the line of the National Institutes of Health. We need to infuse large sums of money into the studies relating to social problems (the kind of studies that you are doing, Professor Wigner, where you were willing to take a sabbatical to go away from physics and study what to a large extent is a social problem). I would love to see it. And if you don't know how to spend \$10 billion at first, you have a series of seminars--"How To Spend \$10 Billion." You know, I would gladly spend \$10 billion on shelters, which I consider fairly foolish, if I could get \$10 billion on really getting at the core of the problem of the

mid-twentieth century, viz., the military technology has outpaced our social technology, and how are we going to close that gap?

Dr. Weinberg: I think most of us will agree to this. We do have some distinguished social scientists in the audience. Perhaps they would like to comment on what they would do with \$10 billion besides raise their salaries. Dr. Bobrow, would you like to comment on this?

Dr. Bobrow: Ten billion a year seems unrealistic in view of our present funding from the Oak Ridge National Laboratory.

Dr. Weinberg: Did you hear that out there? It seems unrealistic in view of the present careful spending of the social scientists at the Oak Ridge National Laboratory. Is there a question back there? Perhaps you could stand and speak loud and clear because that mike is really not a very good one.

My name is [Elias P.] Gyftopoulos from MIT. I would like to address my question to Professor Wigner. In one of your conclusions, you seemed to indicate that shelters would protect millions of lives for one month, and the cost was based on this one-month basis. Implicit in this conclusion is that there will be no further attack after one month, which implies that we are certain that the enemy will be, of course, incapacitated and since we are so certain, so is the enemy about his own resources. And if this is true, why then would he dare attack us?

Dr. Weinberg: Could you repeat the question, Eugene?

Professor Wigner: No, I could not.

Dr. Weinberg: Well, I only got part of the question, that: why do you stop at one month? What prevents the attackers from continuing after one month?

Professor Gyftopoulos: Well, if the shelters would be adequate for only one month, and that's what we need, this implies that after one month there will be no further attack. Now we are counting on it.

Dr. Weinberg: We are what?

Professor Gyftopoulos: Counting on it. I mean that is how we are making our calculations. We are relying on this fact. This implies that we are certain that the enemy would be wiped out, and therefore the enemy must also be certain about it himself, that he will be wiped out. So if

he is so certain that he will be wiped out so that he cannot attack us again after a month, why would he dare a nuclear attack in the first place?

Professor Wigner: I think you point to a very important weakness of...

Dr. Weinberg: Excuse me, did everybody hear the question? Will you repeat the question, Eugene?

Professor Wigner: Yes, the question is this: I talked only about the one-month sheltering period and said, and implied, that after one month no further attack would come. Does this mean that I assume that the enemy's aggressive or offensive system will be wiped out during that month and if it will be wiped out will our offensive system not be wiped out also? A very important, very difficult question which points to one of the weaknesses of our present thinking. My answer is partly that I do think that even if the hostilities lasted for only a few days people will somehow be sobered up. Principally, however, I hope that the fact that the United States would survive will discourage an attack in the first place. In other words, I consider the most important result of an effective civil defense system not that it keeps us alive (that it protects us from attack for one month) but that it altogether discourages attack. Because you can't defeat the country, you can't conquer it, you do something else. Improve the schooling system or the hospitals or something else in your own country. And that is all for the good. If this does not work and if a country just the same attacks us, it is true that unless its aggressive power is wiped out after one month, we are in great trouble. However, most of it will probably be wiped out. At any rate, it is not clear why the attacking country should save up much of its aggressive force and expose it to our destructive strength. It would probably shoot most of what it has at once. I cannot be absolutely sure that it would and this constitutes a problem which I don't want to deny.

Dr. Weinberg: Dr. Cavers.

Professor Cavers: If I might add a word to that and thereby get in something I left out earlier. This is an example, I think, of the fact that we have got to look upon these problems from the standpoint of both the principal participants. We may think of ourselves as invulnerable, and therefore think there is no great likelihood of anybody threatening us.

At the same time from the other person's standpoint we may not seem just as reliable as we seem to ourselves; we might seem a menace, particularly during that period when we are achieving this invulnerability. One of the panels of the Project Harbor studies reported (and this I think is also relevant to Dr. Taylor's suggestion of a \$10 billion program)--one panel predicted that a civil defense program of \$10 billion or more a year would be viewed by the Soviets as a military threat, that it would be viewed as a warlike and provocative act. I don't think we can overlook that as one of the possible consequences of our pursuing our defense in this manner.

Dr. Taylor: Could I have thirty seconds?

Dr. Weinberg: Go ahead, Dr. Taylor.

Dr. Taylor: I want to make just one comment on what Professor Cavers just said. It seems to me that there is at least one way by which we could make it, I think, quite clear to the Soviet Union that the reason we were spending \$10 billion a year (or \$5 billion a year) on a civil defense program had nothing to do with an antagonistic feeling toward Russia, and that is to ask her to join us in the effort. It seems to me that many of the reasons for a large civil defense effort are equally strong in Russia, for exactly the same reasons as they are in the United States, and that the reasons can be so clearly displayed in ordinary language that they would be convincing, not only to each other, but also to the rest of the world. I believe some joint undertaking which at least examines some of the technical problems should be carried out. I am not proposing a cost-sharing enterprise with the Soviet Union, but an analysis of some technical aspects of the problems of civil defense. I see no loss in United States security by making some of the attacks on the problem jointly with the Soviet Union. This is no panacea for this problem of exhibiting some warlike aspect to somebody who will take it that way, but I think it would help a good deal. That is why I keep harping on the internationalized aspects of all these measures.

Professor Wigner: Let me add one sentence to this, namely, that we do spend \$60 billion a year on our defense. If we replace \$10 billion of this by real defense which in no way can be used for aggression, I don't see how this can alarm anybody.

Professor Stonier: I strongly disagree with that.

Dr. Weinberg: Dr. Stonier.

Professor Stonier: Because I think until such a time as when there exists a true accord between us and the Russians, and we can together maintain a safe world--until such a time, we are in a state of considerable potential hostility, although for the moment it has calmed down. We don't know what particular incident could set it off again. There are nations which would be delighted to make trouble between us and them and perhaps will. The thing gets to be terribly "iffy" so that if we suddenly.... How would we view it if the Russians suddenly went ahead with a big civil defense program? I am sure there would be quite a number of voices in this country saying, "Aha! They are getting ready to carve us up. Maybe they have an antimissile missile system already and therefore they have the edge on us." And you know, it will be like the missile gap, or any other real or imagined inequality in armaments. If either side engages in a civil defense program, the response will be for the other side not only to get more civil defense but also to worry that their retaliatory attack pattern is no longer credible. So, they are going to have to up the megatonnage delivered. My main fear aside from whether technically civil defense is sound or not is whether civil defense may not simply lead to a further escalation of the arms race. And, if so, we are spending an awfully lot of money in the wrong direction. Incidentally, one other figure: How much are we spending on the Arms Control and Disarmament Agency? I think the figure is only 15 million. It is absurd!

Professor Wigner: Exactly the amount which the Arms Control and Disarmament Agency wanted. There was not a penny subtracted from it.

Professor Stonier: Yes, I know, but as far as I am concerned that is simply because public climate and public education has not moved sufficiently far along. I am not kidding when I say that I can envision a disarmament program involving several billion dollars a year. Just massive student exchanges, with us footing the bill, could run into that kind of money.

Professor Wigner: The exchange of students is a wonderful thing. Why don't you propose it? We will see whether the Russians will accept it. Wonderful idea. You propose it. If the Russians accept it, I will give you a hundred dollars right there.

Dr. Weinberg: I think there is a question back there.

I am A. J. Smith.

Dr. Weinberg: Could you try it without the mike? The mike doesn't seem to work very well--just shout.

Mr. Smith: Can you hear me?

Dr. Weinberg: Yes.

Mr. Smith: I am A. J. Smith, a shelter owner from Albuquerque, and I just want to make an observation. It seems to me from listening to the panel that the best individual strategy is to build your own shelter while at the same time violently oppose civil defense. (Laughter)

Dr. Weinberg: You all heard the statement that the panel seems to have persuaded the gentleman from Albuquerque that individual shelters are more effective than public shelters. Would you care to enlarge on this? Question?

Dr. Herbert M. Parker (BMI, Pacific Northwest Laboratory): May I address a question to you, Dr. Weinberg? Did you deliberately set up this meeting to support one of the major points of the opposition? I refer to the antisocial behavior under stress, a factor that was mentioned earlier. It is very hot and thirst-making in this room; besides, the privileged people are enjoying cool water. It will not be too long before our normal behavior will break down and we come and take it away from you.

Dr. Weinberg: I think Dr. Parker points out a serious shortcoming in this particular shelter, namely, that it is not equipped with the ventilation system and the water system that Dr. Wigner envisaged. And, therefore, in view of the lateness of the hour, I think we shall unfortunately and unhappily have to bring these proceedings to a close. I would like to exercise my prerogative as chairman, however, to make the following observation. The questions which were being discussed here this evening are deeply important. They go to the root of our society's survival; they affect each one of us. They will affect our children and our grandchildren. I suppose in thinking of the discussions that we had this evening, I could not help to be struck with the fact the debate was brilliant, the arguments were presented persuasively, the points were made in

telling fashion. But I think somehow that issues of this sort are too important to be decided by public debate. I think that the Society, and particularly Mr. Blizard who conceived this symposium, has done all of us a very great service by arranging this public debate. The public debate itself does not settle the issues or present them in definitive fashion; I hope, rather, that it encourages each of you to think about these questions and to read the Harbor Report, which was distributed to all the members of the American Nuclear Society, and make up your own minds as to whether or not you believe that the arguments presented there are convincing. I believe that few issues facing our country today are as important as this one and on no issue is there a greater stake in each of us as citizens of the United States coming to a correct decision. I want to thank each of our panelists for spending his time here imparting to you his wisdom as he sees it on this very knotty problem, and I want to thank each of you for the forbearance which you have shown on a hot and stuffy night in a very large but unequipped shelter. Thank you very much and good night.

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